# Guadalupe Mountains NP and Carlsbad Caverns NP
# Geological Resources Inventory Workshop
# *March 6-8, 2001*


**SUMMARY**

A Geologic Resources Inventory (GRI) workshop was held for both Carlsbad Caverns (CAVE) and Guadalupe Mountains (GUMO) National Parks over March 6-8, 2001. The purpose was to view and discuss the park's geologic resources, to address the status of geologic mapping for compiling both paper and digital maps, and to assess resource management issues and needs. Cooperators from the NPS Geologic Resources Division (GRD), Natural Resources Information Division (NRID), Carlsbad Caverns, Guadalupe Mountains, as well as academics from the Colorado School of Mines, the New Mexico Bureau of Mines and Mineral Resources and the Texas Bureau of Economic Geology were present for the workshop.

This involved single-day field trips to view the geology of both GUMO (led by Gorden Bell, Mike Gardner, and Charlie Kerans) and CAVE (led by Paul Burger), as well as another full-day scoping session to present overviews of the NPS Inventory and Monitoring (I&M) program, the GRD, and the on-going GRI. Round table discussions involving geologic issues for both GUMO and CAVE included the status of geologic mapping efforts, interpretation, paleontologic resources, sources of available data, and action items generated from this meeting.


## OVERVIEW OF GEOLOGIC RESOURCES INVENTORY (GRI)

The NPS GRI has the following goals:

1. to assemble a bibliography of associated geological resources for NPS units with significant natural resources; "GRBIB",

2. to compile and evaluate a list of existing geologic maps for each unit,

3. to develop digital geologic map products, and

4. to complete a geological report that synthesizes much of the existing geologic knowledge about each park.

It is stressed that the emphasis of the inventory is ***not*** to routinely initiate new geologic mapping projects, but to aggregate existing "baseline" information and identify where serious geologic data needs and issues exist in the National Park System. In cases where map coverage is nearly complete (ex. 4 of 5 quadrangles for Park "X") or maps simply do not exist, then funding may be available for geologic mapping.

After introductions by the participants, Tim Connors presented overviews of the Geologic Resources Division, the NPS I&M Program, the status of the natural resource inventories, and the GRI in particular.

He also presented a demonstration of some of the main features of the **digital geologic database** for the Black Canyon of the Gunnison NP and Curecanti NRA in Colorado. This has become the prototype for the NPS digital geologic map model as it reproduces all aspects of a paper map (i.e. it incorporates the map notes, cross sections, legend etc.) with the added benefit of being geospatially referenced. It is displayed in ESRI ArcView shape files and features a built-in help file system to identify the map units. It can also display scanned JPG or GIF images of the geologic cross sections supplied with the map. Geologic cross section lines (ex. A-A') are subsequently digitized as a line coverage and are hyperlinks to the scanned images.

The developing NPS Theme Manager was also demonstrated for adding GIS coverage's into projects "on-the-fly". With this functional browser, numerous NPS themes can be added to an ArcView project with relative ease. Such themes might include geology, paleontology, hypsography (topographic contours), vegetation, soils, etc.

***GRBIB***

Prior to the scoping session, each participant was e-mailed a Microsoft Word Document for Geologic Bibliographies for both GUMO and CAVE.

The sources for this compiled information are as follows:

- AGI (American Geological Institute) GeoRef
- USGS GeoIndex
- ProCite information taken from specific park libraries

These bibliographic compilations were then validated by GRI staff to eliminate duplicate citations and typographical errors, and check for applicability to the specific park. After validation, they become part of a Microsoft Access database parsed into columns based on park, author, year of publication, title, publisher, publication number, and a miscellaneous column for notes.

From the Access database, they are exported as Microsoft Word Documents for easier readability, and eventually turned into PDF documents. They are then posted to the GRI website at: http://www2.nature.nps.gov/grd/geology/gri/products/geobib/ for general viewing.

***EXISTING GEOLOGIC MAPS***

After the bibliographies were assembled, a separate search was made for any existing surficial and bedrock geologic maps for GUMO and CAVE. The bounding coordinates for each map were noted and entered into a GIS to assemble an index geologic map. Separate coverage's were developed based on scales (*1:24,000, 1:100,000*, etc.)

available for the specific park. Numerous geologic maps at varying scales and vintages cover the area.

## GEOLOGIC MAPPING

### Existing Geologic Maps

The USGS has published Professional Papers (PP) on both the Texas and New Mexico portions of the Guadalupe Mountains. **PP-215** (by Phil King, circa 1948) covers the Texas portion of the Guadalupes (GUMO) and contains a geologic map at 1:48,000 scale that ends at the Texas state line. **PP-446** (by Phil Hayes, 1964) covers the New Mexico portion of the Guadalupe Mountains (CAVE) and contains a geologic map at *1:62,500 scale*. CAVE staff have supplied GRI staff with a preliminary digitized version of this map that needs some additional attribution. Both were excellent, very comprehensive publications for their day and still are quite useful even though interpretations have been refined since their publication.

The USGS has also published a few other maps that cover the CAVE area. **MF-1560-a** ("Mineral Resource Potential and Geologic Map of the Guadalupe Escarpment Wilderness Study Area, Eddy County, New Mexico") is mapped at *1:24,000* scale. **GQ-112** and **GQ-98** are also published as separate maps that predate PP-446 and are both at *1:62,500* scale. Of note, however, is that MF-1560-a only covers the southwestern-most portion of CAVE.

All of these maps were considered worthy of digitizing as they represent some of the best sources of existing "baseline" data. GRI staff will incorporate the digitization of these maps into their future workplan.

Also, the Colorado School of Mines (under the direction of Mike Gardner), has been concentrating their efforts on large-scale mapping of the Permian Reef at GUMO, specifically the Brushy Canyon unit. They have digital versions of this mapping in ArcView format and are willing to share it with the NPS.

### Desired Enhancements to the Existing Maps

***CAVE 1:24,000 scale mapping***

Paul Burger would like to see the six main "quadrangles of interest" for CAVE (Queen, Serpentine Bends, Carlsbad Caverns, Gunsight Canyon, Grapevine Draw, and Rattlesnake Spring) mapped at *1:24,000* scale. At this time, it is not known if Hayes compilation map at *1:62,500* scale was compiled from original *1:24,000* scale maps. If they were, then the data is essentially already there. GRD will attempt to discern if this is true for the Hayes map.

Peter Scholle mentioned that the New Mexico GS will be producing a geologic map of the Carlsbad West quadrangle at *1:24,000* scale, but this is not one of the parks quadrangles of interest, as it lies directly west of the actual town of Carlsbad, which is northeast of CAVE proper. He also thought that the Hayes maps need refinement in the CAVE area.

Paul would also like to see more detailed mapping of the Yates-Tansill contact because it is the location from where water emanates to become the parks water supply.

***Suggested improvements to the existing maps***

- Refinements to King's maps would involve splitting out the Carlsbad Group into three formations (Yates, Tansill, Seven Rivers formations) to seamlessly edge-match that of Hayes map (and hence eliminate the New Mexico/Texas "boundary fault"). Gorden Bell thought that aerial photography and satellite photos could be used to do this with minimal field checking.

- Integrate Mike Gardner's large scale mapping of the Western escarpment with the King map for better detail for the Brushy Canyon unit members which also include some minor faults that are not shown on King's maps

- Work out the subdivision of the Bone Spring versus the Cutoff formations where the units are shown but the interpretations have changed over time

- Work out the Victorio Peak-San Andres problem which relates to Goat Seep (which is really now known as the Grayburg and Queen);

- Resurveying of roadcuts is desired in and around both parks

- Hazard and rockfall assessments should be conducted, although most susceptible areas don't seem to affect facilities

- Essentially re-map approximately one quadrangle worth of mapping on Carlsbad Group in GUMO (not quad specific); New Mexico Bureau estimates ~$100,000 to do that work

***Use of LIDAR technology for higher resolution***

Charlie Kerans and Mike Gardner would see the use of LIDAR technology as a great asset to refining any mapping and future research, and would like to have this data available for the Guadalupe Mountains and Delaware Basin in the very near future.

They "rough" estimated the data acquisition at between $60,000 for a "poor-man's DEM" to $100,000 for full LIDAR coverage.

Various ideas were proposed on how to go about accomplishing this task and need to be followed up on by the cooperators. Joe Gregson told the group of the Department of the Interior (DOI) high priority program to obtain funds through regions to obtain such LIDAR information. He mentioned that leveraging with adjacent land managing agencies (Forest Service, BLM, etc) often is the most successful way to acquire funding for obtaining this technology

Mike Gardner made the suggestion that the Colorado School of Mines, NPS, and Texas and New Mexico Geologic Bureaus cost share to acquire the LIDAR data for the region.

The NPS could not guarantee such funding allocations for FY-2001, but Joe said he would talk to Ingrid Langraf (USGS) about any available funding and would report back to the group at a later time on what he finds out.

Here is what Joe was able to find out as of March 14, 2001:
*"At the GUMO/CAVE geologic resources inventory scoping workshop, the group expressed interest in obtaining LIDAR data for the parks and adjacent area to support geologic mapping, research, and resource management. Here is what I found out about getting high resolution LIDAR elevation data for the parks and Delaware Mtns. via the NPS/USGS agreement.*

*The USGS does not do a direct 50/50 cost share on LIDAR as with other base cartography but does have contractors available that can fly the area and supply the data. Right now, the ball park cost is about $10K per quadrangle. Contiguous GUMO and CAVE coverage would require about 15-16 quads plus 6-8? quads (guessing) for the Colo. School of Mines (CSM) study area. That puts the project costs in the $200K-$250K range. The best avenue for funding the project (at least for the NPS part) appears to be the Dept. of Interior High Priority Program which annually funds data projects for DOI bureaus. Through the NPS Intermountain Region, CAVE and GUMO park staff can request high resolution elevation data with requirements for LIDAR. If the parks can get other DOI bureaus (BLM, BOR, BIA, USGS, etc.) to also request the data, it has a very good chance of being funded. Unfortunately, the DOI Program call is past for this year, and it runs a year in advance (i.e., a request next year would get put into work in FY 2003 at the earliest).*

*I know this does not address the immediate needs of CSM that were discussed at the workshop, but it is the best that I could come up with at the moment. If anyone has other ideas for data sources or funding and wishes to pursue this further, let me know."*

**DIGITAL GEOLOGIC MAP COVERAGE**
As stated earlier, it was agreed upon by the consensus of the group that the King and Hayes maps were worthy of digitization with the caveat of the "Desired Enhancements" listed above. Once the maps exist in a digital format they are easier to refine both in the field and electronically.

GRI staff in Denver will attempt to accomplish this digitization in their workplan in FY-2002. Of note, is the existence of digital linework for the Hayes 1964 map in PP-446, but there is no accompanying metadata. GRI staff would also like to get it attributed as per their NPS digital geologic map model. Dave Roemer (CAVE-GIS) will need to be consulted for more specifics on metadata for this coverage.

Charlie Kerans thought that another additional piece of information that should be tied to any digital geologic database would be measured stratigraphic sections that could be georeferenced and brought up in a GIS. This should be easy to add in to the NPS Digital Geologic Database Model.

**Other desired GIS data**

***General needs***

Paul Burger would like to see a GIS coverage for linear features for CAVE (Kim Cunningham and Dave Yagnow) for the Dark Canyon Environmental Impact Statement (EIS). Additionally, he is interested in a delineated watershed for Rattlesnake Springs, which is the sole water supply for city of Carlsbad. Ground Penetrating Radar (GPR) or an electromagnetic survey could be used to delineate this.

***Soils***

Pete Biggam (GRD Soil Scientist) supplied the following information in reference to soils for both parks:

*" We currently have in place an Interagency Agreement with the TX - NRCS to map all NPS units in Texas, based upon an estimated completion by 2005 (as funding allows)*

*We are estimating that we might initiate soils mapping at GUMO in 2003, and would be utilizing the NRCS soil survey crew that is currently located in El Paso, TX. This, of course, is dependent on funding being provided by NPS I&M for this effort.*

*We would also be looking at initiating soils mapping at CAVE and WHSA in a similar timeframe.*

*We operate similar to the GRI, we would schedule a soil scoping session, look at soils research that was already performed at GUMO, map it to National Cooperative Soil Survey Standards with local input from GUMO in regards to their soil resource management concerns.*

*Products would be a digital soils map, digital soil attributes, metadata, soil report, as well as potentially some soil information/education products which could be incorporated into GUMO's interpretive program. There would be data that would be utilized within the NPD GIS Theme manager as well, similar to what is being done with GRI.*

*We would also have a "last acre mapped session", where we would have a soils field tour of the park."*

***Geologic Hazards***

GUMO has a published hazards map from R.R. Railsback (University of Texas at Dallas) that was done in 1976. It has been digitized by Parsons Engineering. It is titled

"Geologic Hazards in the Pine Springs Canyon area, Guadalupe Mountains National Park.

Vicky Magnis (NPS-IMR GIS) apparently has this data in digital format from Parsons Engineering and it is currently being tracked down by Tim Connors. It is unknown what format the data is in (AutoCAD, ArcView etc. ??). Vicki will be working with GUMO staff on the GIS portion of their General Management Plan (GMP).

***Paleontology***

Greg McDonald (GRD Paleontologist) would like to see an encompassing, systematic Paleontological inventory for both GUMO and CAVE describing the known resources in both parks with suggestions on how to best manage these resources.

***Other Sources of Data***

- Charley Kerans did a presentation on "Hierarchical Stratigraphic Analysis of a Carbonate Platform, Permian of the Guadalupe Mountains". He mentioned that much of this data will be out in CD-ROM in the near future. It will likely be available from the Texas Bureau of Economic Geology website (http://www.beg.utexas.edu). GRI staff are interested in obtaining a copy of this once it is available to the public.

- The Colorado School of Mines has a website for research on the slope and basin consortium at http://www.mines.edu/Academic/geology/sbc/

**Interpretation:**

Numerous topics regarding interpretation of geologic resources were discussed. Among these included:

- the Permian Reef complex should be better utilized in both parks as the major interpretive focus, and the tie of the Guadalupe Escarpment between both parks should be made to illustrate the importance of the Capitan Reef as a world-class feature that is unique to this area alone. This should also serve to illustrate the GUMO-CAVE story to the regional picture for Permian time.

- make better use of park trails to showcase and interpret the park geology for visitors

- a Reef diorama in each visitor center showing modern analogs and the process of reef building

- Mike Gardner has offered to assemble a Bone Springs-Shumard trail guide trail for GUMO (for free)

- Make better use of the story of P.B. King's "interpretations" of the reef as a major contribution to the science of geology in general

**Geologic Report**

An encompassing report on each parks geology is a major focus of the GRI. To date both the King and Hayes Professional Papers fulfill a major role in describing the regional geology, but are highly technical and not written for the average NPS Resource Manager.

To this end, it was generally agreed that simpler, toned down reports will need to be written for both CAVE and GUMO. The next task is to find enthusiastic report writers to tackle this chore.

Both states geologic bureaus (Texas and New Mexico) have offered their assistance in reviewing such reports in final format, supplying maps and graphics on the local geology in their existing publications, and offering their general assistance to the NPS. Peter Scholle says his agency is already doing a publication on the geology of New Mexico's State Parks.

Michael Queen (affiliation unknown) was mentioned as someone interested in wanting to write an educated layman's publication for GUMO. However, there was some skepticism as to how serious he is about delivering such a publication.

Paul Burger was enthusiastic about writing such a report for CAVE, and thought this would be a good use of his time as the parks geologist.

Jan Wobbenhorst suggested GUMO geologist Gorden Bell as the logical choice to write such a report for GUMO, as he is the local NPS expert on the geology.

**Miscellaneous:**
In the summer of 2000, NPS natural resource managers from GUMO and CAVE met to brainstorm general geologic issues for each park and came up with a list of topics of interest to them.

They are listed below:

**Minutes from the Brainstorming meeting June 8, 2000**

***Libraries*** *– we have some overlap and some gaps*
- *Gumo theses (have all of Pray's group)*
- *Geo-Ref*
- *NRBIB*
- *Peter Scholle website*
- *Digital publications*
- *Need a shared bibliography*

***Paul says there is some overlap and gap between each parks libraries***

***Action items:***

- *Inventory what we have*
- *Look at combined bibliography (Geo-Ref and Scholle) to ID gaps*
- *Fill in the gaps*

***GIS***

- *We have the East and West Carlsbad 15-minute geology maps (ca 1957) digitized*

- *GUMO has applied for SEPAS funding for 7.5 minute geologic mapping (field asst., GRD will digitize)*

- *Other digital data needs:*
  - *linear features (lineaments)*
  - *springs/seeps*
  - *soils maps*
  - *GUMO-springs/seeps*
  - *GUMO-caves*

***Do CAVE and GUMO share cave coordinator? Probably not as much as they should. Dale Pate is CAVE cave specialist***

***Williams Cave has cultural materials in it; soon to become NAGRA (native American graves and repatriation act) site***

- *paleontological locations*
- *geological hazards*

*Data synthesis could be done by GRD or Albuquerque GIS shop*

***Research***

- *David Hunt – syndepositional faulting in the backreef*
- *Cave Microbiology – Spider and Lechuguilla*
- *Cave Development in the Guads – synthesis publication due out this fall*
- *Infiltration study – used for Environmental assessment*
  *Proposed dye trace of Bat Cave Draw (CAVE staff)*
- *GUMO- sponge paleo., geopetals, Sr isotope dating*
- *GUMO- deep channels (Gardner's group)*

***Gorden says IARs get done, but investigators don't catalog paleo specimens***

- ***add hydrologic studies, quaternary studies, gypsum dunes***
- ***David Wilkins did Quaternary mapping of the Salt Flat Basin***

***Action Items:***

- *Park-driven research GMP's, RMP's, etc.*
- *Ideas from GRD, WRD*

***Geologic Interpretation (*action items)***

- *Geology Trails: Surface and *Cave*
- *3-D geologic and geomorphic representation of cave and trails*
- **Geologic Story / Core Knowledge (need to get the word out to RM, Interp, visitors)*
- *GUMO- roadside geology waysides targeting lay people*
- *Include both ancient and modern processes*
- *GUMO- global stratotype section of the Middle Permian*
- *How do we relate geology to a visitor's own experiences?*

***Partnerships (money, technical guidance and reviews, articles for us, etc.)***

- *NCKRI (caves and karst institute)*
- *GRD*
- *USGS*
- *Oil Industry*
- *course materials*
- *updating our libraries*
- *technical assistance*
- *presentations and programs*

*WIPP- other national labs*
*Universities*
*students*
*faculty- NSF monies*

***Partnerships: any chance of getting pubs from oil companies as they close down and get rid of their goodies to fill up NPS libraries***

***Contact AAPG for donations of collections from retirees looking to dump their collections***

*Action Item: Start making the contacts*

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| NAME | AFFILIATION | PHONE | E-MAIL | GUMO field trip | CAVE field trip | scope |
|---|---|---|---|---|---|---|
| Joe Gregson | NPS, Natural Resources Information Division | (970) 225-3559 | Joe_Gregson@nps.gov | **YES** | **YES** | **YES** |
| Tim Connors | NPS, Geologic Resources Division | (303) 969-2093 | Tim_Connors@nps.gov | **YES** | **YES** | **YES** |
| Bruce Heise | NPS, Geologic Resources Division | (303) 969-2017 | Bruce_Heise@nps.gov | **YES** | **YES** | **YES** |
| Steve Fryer | NPS, Natural Resources Information Division | 970-225-3584 | Steve_Fryer@nps.gov | **YES** | **YES** | **YES** |
| Greg McDonald | NPS, Geologic Resources Division | 303-969-2821 | Greg_McDonald@nps.gov | **YES** | **YES** | **YES** |
| John Graham | NPS, Natural Resources Information Division | 970-225-6333 | John_p_Graham@nps.gov | **YES** | **YES** | **YES** |
| Gorden Bell | NPS, Guadalupe Mountains NP Geologist | 915-828-3251 ext. 249 | Gorden_bell@nps.gov | **YES** | **YES** | **YES** |
| Jan Wobbenhorst | NPS, Guadalupe Mountains NP Chief of Natural Resources | 915-828-3251 ext. 109 | Jan_wobbenhorst@nps.gov | **YES** | **YES** | **YES** |
| Fred Armstrong | NPS, Guadalupe Mountains NP Natural Resources | 915-828-3251 ext. 251 | Fred_armstrong@nps.gov | **YES** | **YES** | **YES** |
| Paul Berger | NPS, Carlsbad Caverns NP | 505-785-2232 ext. 394 | Paul_Burger@nps.gov | **YES** | **YES** | **YES** |
| Peter Scholle | New Mexico Bureau of Mines and Mineral Resources | 505-835-5302 | Pscholle@gis.nmt.edu | **YES** | **YES** | **YES** |
| Mike Gardner | Colorado School of Mines | 303-384-2042 | Mgardner@mines.edu | **YES** | **YES** | **YES** |
| Charles Kerans | Bureau of Economic Geology Univ. of Texas at Austin | 512-471-1368 | Charles.kerans@beg.utexas.edu | **YES** | **NO** | **YES** |
| Greer Price | New Mexico Bureau of Mines and Mineral Resources | 505-835-5752 | Gprice@gis.nmt.edu | **YES** | **YES** | **YES** |
| Dale Pate | NPS, CAVE Cave Specialist | 505-785-2232 | Dale_pate@nps.gov | **NO** | **NO** | **NO** |
| Vicki Magnis | NPS, IMR GIS | 303-969-2962 | Viktoria_magnis@nps.gov | **NO** | **NO** | **NO** |
| Dave Roemer | NPS, CAVE GIS | | Dave_roemer@nps.gov | **NO** | **NO** | **NO** |

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| NAME | AFFILIATION | PHONE | E-MAIL | GUMO field trip | CAVE field trip | scope |
|---|---|---|---|---|---|---|
| Doug Buehler | NPS, GUMO Interpretation | 915-828-3251 ext. 105 | Doug_buehler@nps.gov | **NO** | **NO** | **YES** |